silica is merely compressed by more than 60% of full density. In one process, a silica-based glass ceramic is melted, mixed with silicon carbide reinforcement and cast into the desired shell shape.--

Please replace the paragraph beginning at page 11, line 11 with the following rewritten paragraph:

--The induction heating used in the present invention is varied along axial portions of the tubular blank and the quenching is also controlled along the axial length of the blank. In this manner, the forming operation is optimized and the metallurgical properties of the resulting structural component are optimized. Since the invention is a hot forming process, it provides a means to significantly improve material formability. Within the acceptable forming time (i.e. 15 seconds), or deformable speed (strain rate greater than 0.1 per second), the process achieves more than 100% uniform tensile elongation for several aluminum alloys, as compared to about 30% in cold forming processes. The hot metal gas forming provides enhanced formability, thus greatly enhances manufacturability of structural parts and offers increased design flexibility. Consequently, the process part has reduced weight, tooling costs and development time.--

Please replace the paragraph beginning at page 16, line 24 with the following rewritten paragraph:

--Although a number of machines and mechanical components could be used for practicing the present invention, the preferred embodiment involves a multi-station machine 20 shown in FIGURES 2-4 having the loading or preprocessing station 22, the actual hot metal gas forming station 24 and the novel quench station 26. In the illustrated machine 20, there is a lower support frame 30 having an upper fixed table 32 overlaid by an upper fixed head 34. Transfer mechanism 40, shown in phantom lines, is a walking beam type of transfer mechanism for shifting the plugged blank a into station 22 for moving the blank or workpiece a to station 24 where it is hot metal gas formed in accordance with the invention and for then moving the formed structural element A to quench station 26 where the heated and formed workpiece is quenched along its length by liquid and/or air quenching. Referring now to initial or loading station 22, a generally rectangular holder 50 has a nest 52 for receiving the plugged tubular blank or workpiece a. The optional preforming

shown in FIGURE 22 or resistance heating is not illustrated. From loading station 22, workpiece a is moved to the hot metal gas forming station which involves a die set 60 having a lower die member 62 and an upper die member 64 which are brought together to form a cavity or shell 66 defining the desired outer configuration of structural component A after it has been processed in accordance with the present invention. Lower die member 62 is supported on fixed table 32, whereas the upper die member is carried by a platen 70 movable on rods or posts 72 by four spaced bearing housings 74 between a closed lower position shown in the solid lines of FIGURE 2 and an upper open position shown by the phantom lines in FIGURE 2. Post 72 not only reciprocally mounts the upper die member 64, but also fixes machine head 34 with respect to the lower fixed machine table 32. Movement of die member 64 is accomplished by cylinder 80 fixed on head 34 and joined to platen 70 by rod 82. Movement of the rod 82 by cylinder 80 raises and lowers die member 64 to open and close the die member 60 for loading and unloading station 24. As will be described later, one or both die members include a number of axially spaced induction heating conductors embedded within the die members to heat the metal of blank a to a temperature about 1800°F. The temperature can be varied along the length of the workpiece. Such heating is done by induction heating which raises the temperature of the workpiece by inducing voltage differentials using an alternating current in the coils or conductors surrounding the workpiece during the forming operation. In the preferred embodiment, collets 104, 106 surround the ends 10, 12 which extend outwardly from holes 68 in die set 60 as best shown in FIGURES 3, 4, 17 and 18. These collets are forced inwardly by feed cylinders 100, 102, respectively, so that metal is fed into cavity of shell 66 during the hot metal gas forming process in a manner similar to such in-feed of metal during hydroforming of steel. Inert gas, nitrogen or argon, at high pressure in the range of 200-1000 psi is forced into the heated workpiece to expand the workpiece into shell or cavity 66. The gas is capable of expanding the steel which has a wall thickness in the range of 0.04-0.35 inches and preferably less than 0.25 inches. The metal is heated to a temperature in the general neighborhood of 1800°F and subjected to an inert gas pressure of 200-1000 psi. This forming process normally takes less than about 20 seconds and preferably about 10 seconds. In practice, the hydraulic pressure from cylinder 80 exerts a compressive force between die members 62, 64 which is about 100 tons. With this high holding force on die set 60, the hot metal gas forming process does not separate die members 62, 64 during the forming operation.

When the hot metal has been formed in station 24, cylinder 80 moves upper die member 64 by moving platen 70 upward. After the die has been opened, the formed structural element A is moved by transfer mechanism 40 from station 24 to station 26 best shown in FIGURES 2 and 4.--

Please replace the paragraph beginning at page 20, line 21 with the following rewritten paragraph:

--The present invention can be used for producing a large variety of structural components. To illustrate the versatility of the present invention, an H-shaped structural element B is formed by the method of the present invention. Tubular blank b is shown in FIGURES 7-12. Two H-shaped steel plates 250a, 250b with a laser welded center portion 250c are joined together in a manner where legs 252a, 254a, 256a, 258a are seam welded to legs 252b, 254b, 256b and 258b, respectively to form tubular blanks identified as legs 252, 254, 256 and 258 in FIGURE 8. The outer edges of the plates are laser welded together as shown at seam W in FIGURE 10. Overlying welded legs 252 and 254 form a single hollow workpiece. In a like manner, seam legs 256, 258 form a single hollow workpiece. These tubular legs are like workpiece a shown in FIGURES 2 and 4. Center portion 250c is welded together to form a generally flat structural element, but it does not constitute necessarily a portion of the tubular workpiece to be formed. After seam welding legs 252, 254, 256 and 258 to form workpiece b, the legs are trimmed to the desired length by removing excess portions 262, 264, 266 and 268 by trimming the ends of the respective legs. This trimming action produces a workpiece b, as shown in FIGURE 9, which workpiece is in the form of two generally parallel tubular blanks. In accordance with the invention, plug 270, having a wedge shaped nose 272, is forced hydraulically into the end of each of the legs 252, 254, 256 and 258. Each of the plugs 270 includes a gas inlet 274 with a flared gas passage 276. As shown in FIGURES 10-12, plugs 270 are forced in the end of each of the legs so gas G can be forced into each of the legs to expand the legs into the shape of the H-shaped shell of die members 60, 62 having shells or cavities formed in accordance with the desired shape of structural component B illustrated in FIGURE 13. During the forming process, the workpiece is heated inductively by coil 280 encircling legs 252, 256 and driven by high frequency power supply 282. In a like manner, induction heating coil 290 encircles legs 254, 258 and is energized by a high frequency power supply 292. In accordance with an aspect of the invention, the

coils 280, 290 are operated at different cycles 50 of the respective legs being formed are heated differently, in accordance with an aspect of the process of the invention. Thus, portions 300, 302 of legs 252, 256, respectively, are heated substantially less than portions 304 and 306 of legs 254, 258. This representation of the present invention illustrates that the induction heating equipment associated with the die set allows processing of the workpiece being formed at different temperatures to obtain the desired forming rate. It is part of the invention that a greater portion of legs 254, 258 be heated during the forming process than the portion being heated in legs 252, 256. However, all of the metal being formed must be at a temperature of at least about 1400-1500°F. This is a novel concept of heating portions of the workpiece differently. In the past, when induction heating was used for superplastic deformation of sheet material, the total sheet material was heated the same. Thus, the requirement for different heating at different sections could not be accommodated by use of the prior superplastic heating processes used for flat plate material.--

Please replace the paragraph beginning at page 23, line 23 with the following rewritten paragraph:

--The versatility of tuning the induction heating along the length of the workpiece is illustrated in another embodiment of the invention wherein a tubular workpiece is to be formed into a complex tubular structural shape as defined by shell 200' in die members 62', 64' of die set 60' as shown in FIGURE 15. This shell will cause the tubular workpiece to have different diameters and shapes in areas 402, 404, 406, 408 and 410. In these different areas, a different amount of heat is required for deformation and the desired characteristics of the workpiece. Consequently, the die members are provided with a plurality of encircling induction heating coils 402a, 404a, 406a, 408a and 410a, respectively. These encircling coils are spaced axially along the shell or cavity 400 defining the final outer shape of the tubular structural component being formed by using the present invention. In accordance with this aspect of the invention, each of the separate coils has a specific frequency and a specific power level. Several power supplies PS1, PS2, PS3, and PS4 are provided to create the different frequencies and power levels for coils 402a-410a. As illustrated, power supply PS1 has a frequency F1 and a power level P1. This power supply is connected to encircling inductors 402a and 408a. In the same fashion, power supply PS2 has a frequency F1 which is the same as PS1

but a different power level P2. This power supply energizes encircling coil 410a. In a like manner, power supply PS3 has a frequency of F2 and a power level of P3. This power supply drives encircling inductor 404a. In a like manner, power supply PS4 has a frequency of F3 and a power level P4 for energizing encircling coil 406a. By changing the heating frequency and power level the heating cycle during the forming process is modulated and changed along the length of the workpiece. This is used not only for controlling the amount of heat for the purposes of optimizing the forming operation, but also to optimize the metallurgical processing of different sections of the workpiece. It is necessary to raise the temperature of the total length of the workpiece being formed to a temperature in the range of 1400°F-1800°F. Consequently, the areas of shell 200' without coils or conductors will be short if they exist at all. It is preferred to use a large number of conductors with the heating effect changed, such as shown in FIGURE 15 but by various arrangements.--

Please replace the paragraph beginning at page 26, line 7 with the following rewritten paragraph:

--The invention uses the concept of positively feeding metal into the cavity of the die set as the metal is formed. This concept is schematically illustrated in FIGURE 20 wherein a function generator 510 controls servo cylinder 100 forcing the collet 104 inward slightly during the hot metal gas forming process. The process is started as indicated by block 512. In a like manner, cylinder 102 is moved inwardly by a signal from error amplifier 520 having a sensed force signal in line 524. The level of the actual force applied by cylinder 102 is compared to the level of a reference signal in line 522. The error signal controls servo cylinder 102. The illustration in FIGURE 20 is representative. This concept is also used in hydroforming and will be used in practicing the present invention when further implementation of the invention is made. In accordance with an aspect of the invention schematically represented in FIGURE 21, plugs 270 have gas inlets or outlets 274. Gas supply 550 provides an inert gas such as argon at a pressure between 200-1000 psi. This gas is directed to workpiece B by an inlet valve 552. An exhaust valve 554 allows decrease in the internal pressure of workpiece B. Valve 552 increases the gas pressure while exhaust valve 554 decreases the pressure. These valves are controlled by an error amplifier 560 having an outlet 560a that operates valve 552. In the alternative, line 560b controls exhaust valve 554. Function generator 562 provides

one input 562a to error amplifier 560. The other input 570a is created by pressure sensor 570 within workpiece B. Pressure sensor 570 provides a signal in lines 570a that is compared with the output of function generator 562 at line 562a. This determines whether, at a given temperature, represented by the signal in line 572a from sensor 572 additional pressure or less pressure should be provided in workpiece B. Consequently, the pressure is maintained at the desired selected level associated with a given temperature. Control arrangements, both analog and digital, can be used in the preferred embodiment of the present invention.--